Version 6

FIG. 9 illustrates a sixth embodiment of the invention. Spindle 56e is provided with a circumferential groove 96, a portion of which has splines 97. A coupler 60e is designed to slide over the end of the spindle and is then formed to match the splines 97 and to fit the smaller diameter of groove 96. In the process, the coupler is pressed axially against the bearing to preload the bearing and lock the bearing in place. External splines 98 are subsequently formed into the coupler for engagement by the clutch ring.

Version 7

FIG. 10 illustrates a seventh embodiment of the invention.

The spindle 56f is provided with fingers or dogs 100.

Coupler 60f has mated fingers 102 that interlock with the fingers of the spindle (See FIG. 10a) and the protruding end 15 104 of the fingers 102 are then flattened in the manner of a rivet to secure the coupler and in the process preload the bearing 54.

Version 8

FIG. 11 illustrates an eighth embodiment of the invention. 20 The spindle 56g is provided with splines 106 and a coupler 60g having mated splines 108 is slid onto the splines and is compressed against the bearing 54. A space between splines 106, 108 is filled with molten metal 110 to lock the coupler to the spindle and retain the preload against the bearing. 25 Version 9

FIG. 12 illustrates a ninth embodiment of the invention. The spindle 56 is configured at end 61h to mate with the configuration of coupler 60h. The positioning of the bearing 54 is such that with the coupler abutted against the end 61h, 30 the bearing is desirably preloaded. Coupler 60h is then spin welded (friction welded) to the end 61h. FIG. 12a shows a variation of the same embodiment. FIG. 12b is also a variation of the same embodiment. Here the coupler is slid onto the spindle end and the configuration of the coupler 35 60h" provides a slot 112 in which a separate ring 114 is positioned and spin welded. The version of FIG. 12b permits the use of a spline fit as indicated by reference 113.

FIGS. 13, 13a and 13b are similar to FIGS. 12a and 12b. 40 The coupler 60i, 60i, 60i, 60i' is configured to match the ends 61i, 61i' and 61i' of the spindle 56 and the spindle and coupler are welded together following preload, as indicated by weld joints 116. The coupler may also be spline fit as indicated at 117 in FIG. 13. Also, a relief space 119 is 45 exaggerated to demonstrate that the coupler 60i is abutted/compressed against race 54.

Version 11
FIG. 14 illustrates an eleventh embodiment of the invention. A coupler 60j is spline fit to the spindle 56j. The inner 50 diameter 118 of the spindle end 61j is provided with screw threads with mated screw threads provided on retainer 120. A lock washer 122 is fitted between the retainer 120 and coupler 60j. A washer suitable for this purpose is disclosed in U.S. Pat. Nos. 5,772,373 and 5,618,143.

FIG. 14a shows the concept of FIG. 14 but applied to the outboard end of spindle 36j'. Version 12

FIGS. 15 and 15a illustrate a twelfth embodiment of the invention. A coupler 60k is mounted to spindle 56k. End 61k 60 is roll formed against the coupler 60k to provide the desired preload on bearing 54. Coupler 60k is engaged by the clutch ring 68 to provide driving engagement between the axle 32

and the spindle/wheel hub extension 56k. To insure driving engagement as between the coupler and spindle 56k, the coupler and spindle have mated polygonal configurations 124, 126 as illustrated in FIG. 15A. Whereas a hexagonal configuration is shown, other polygonal shapes will be equally satisfactory and including other interlocking shapes such as a double D shape.

FIGS. 16 and 16a illustrate a final and thirteenth embodiment of the invention. Here the spindle end 61m is provided with an outer diameter 128 that is configured to have a larger diameter than that of coupler 60m which is force fit onto the end 61m, e.g., by heating the coupler relative to the spindle and forcing the coupler onto the spindle and against the bearing 54 so that when cooled the coupler incurs a tight and secure fit to the spindle. The outer diameter 128 may also be provided with a negative angle to enhance the tight fit. FIG. 16a illustrates a variation to the force fit by press fitting a dowel 130 into aligned holes 132, 134 in the spindle and coupler, respectively.

The above embodiments provide a number of benefits that will be apparent to those skilled in the art. Whereas the embodiments and variations are numerous, they are not all encompassing and further variations will become obvious. Accordingly, the invention is not limited to the above disclosures but is determined by the definitions provided in the accompanying claims.

The invention claimed is:

1. A wheel end assembly for a vehicle having optional four-wheel/two-wheel drive comprising:

- a wheel hub having an inwardly extending spindle portion configured to have an inboard end and a shoulder spaced outwardly of said inboard end;
- a wheel bearing mounted on said spindle portion for rotatably mounting said wheel hub to a vehicle chassis, said wheel bearing having an outboard end abutted against the shoulder;
- said inboard end of said spindle portion roll formed against an inboard end of said bearing and producing thereby a desired preload on said bearing and securement of said preload;
- said spindle portion at said inboard end being cylindrical to define an inner wall configured to provide a securement feature, a coupler having an outer diameter fitted to the inner wall and mated to the securement feature to provide common rotation of the coupler and the spindle, said coupler having an inboard end protruded from the inboard end of the spindle;
- an axle portion positioned adjacent the inboard end of the coupler and rotatable relative to the coupler and defining thereby adjacent portions of the axle portion and coupler, splines provided on the adjacent portions and a spline engaging clutch ring slidable between engagement with one and engagement with both the splines of the adjacent portions.
- 2. A wheel end assembly as defined in claim 1 wherein the coupler is cylindrical and in cooperation with the wheel hub defines a cylindrical support, said axle portion extended into said cylindrical support and a bearing provided in said cylindrical support for relative rotation of the axle portion.

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